FISH OTOLITHS FROM THE TERTIARY STRATA OF VICTORIA, AUSTRALIA

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[Communicated by Edmund D. Gill, 11 July 1957]

Abstract

Palaeontological studies af the Tertiary strata of Victoria have dealt only briefly with teleostean otoliths which are not uncommon at some horizons. The present paper seeks to rectify this omission by describing otoliths representing 20 species of Teleosts, of which 16 were previously undescribed.

Physical and climatic conditions obtaining during Tertiary times are discussed in relation to the teleostean genera represented.

Introduction

Although otoliths of teleostean fishes are not uncommon in the Tertiary strata of Australia, the subject has been largely neglected. To the present, only 4 species have been described, 3 by G. A. Frost in 1925, from Balcombe Bay, Victoria, and one by the present author in 1952, from the Pliocene of South Australia.

Recently, Edmund D. Gill, Curator of Fossils, National Museum of Victoria, kindly submitted 72 otoliths to the author for examination, and this series has been further augmented by 22 specimens collected by D. Curry during a visit to Australia in 1953. This series comprises 20 species to be described hereafter, 16 of which are new to the Australian Tertiary fish fauna.

All of the specimens are sagitta otoliths, no other type of otolith having so far been reported in Australia.

For details of the morphology of a sagitta otolith, reference should be made to a paper by the author (1952).

All the figured otoliths bear the registration numbers of the National Museum of Victoria, where the collections are housed.

Systematic Description of Species

Sub-class Actinopterygii

Superorder Telelostei

Order Isospondyli

Family Elopsidae

Genus **Megalops** Lacepède, 1803

1803 Lacepède, *Hist. Nat. Poiss., 5*; 269.

Megalops lissa n.sp.

(Pl. XIII, figs. 8, 23)

Types: Holotype P 16938; paratype P 16949.

Dimensions: Fig. 8—Length, 3·63 mm., width 2·22 mm.; Fig. 23—Length, 2·03 mm., width 1·10 mm.

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Description: A biconvex, left sagitta otolith. Posterior and ventral rims rounded, dorsal rim rounded and slightly scalloped anteriorly, anterior rim concave. Outer face showing feeble ribbing on the antero-dorsal part of the otolith. Inner face smooth with a narrow, central sulcus which opens widely on the anterior rim and does not reach the posterior rim. Ostium narrow and shallow with a concave lower rim; cauda down-curving, long, and narrower than the ostium from which it is delineated by a slight lower angle. Marked rostrum, slight antirostrum and excisura. No colliculi. A shallow groove above the crista superior.

Fig. 23 represents a juvenile example and is relatively narrower than the adult form. It also shows some scalloping of the posterior rim, a feature not shown in the adult specimens.

This otolith shows a close resemblance to those of the living *Megalops cyprinoides* Broussonet in the character of its sulcus, but differs in its rounded outline and more markedly concave anterior rim. The specific name refers to the general smoothness of the otolith.

Occurrence and localities: 2 specimens, P 16938-9, Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection. One specimen P 16940, *Limopsis* Beds (Oligocene), Bird Rock, Torquay, Victoria, D. Curry collection.

Family Pterothrissidae

Genus **Pterothrissus** Hilgendorf, 1877

1877 Hilgendorf, *Leopoldina,* 13 (15-16) ; 127.

Pterothrissus pervetustus n.sp.

(Pl. XIII, fig. 21)

Type: Holotype P 16941.

Dimensions: Length 7·68 mm.; width 4·42 mm.

Description: An oval, biconvex, right sagitta otolith, tapering posteriorly. Anterior, posterior and ventral rims rounded; dorsal rim almost straight. Outer face ornamented with small ridges and tuberosities, the latter concentrated towards the centre of the otolith. Inner face smooth. Sulcus diagonal, opening on antero-dorsal rim and not reaching posterior rim. Ostium rectangular; cauda straight, narrow and rounded at its extremity. No rostrum, antirostrum or colliculi present. Excisura present.

This otolith is typical of the genus *Pterothrissus,* resembling those of the living form *Pterothrissus belloci* Cadenat. It is also similar to the common English Eocene form *Pterothrissus umbonatus* (Koken), but the Australian form differs in its posterior tapering while the European form is more rectangular in outline. The specific name indicates an ancestral form of this extant genus.

Occurrence and locality: 3 specimens P 16941-3, Janjukian (Oligocene), Spring Creek, Victoria, Dennant collection.

Frost (*Trans. N.Z. Inst., 55*; 613, 1924) has described a similar form from the Miocene of New Zealand as co-specific with the European *Pterothrissus umbonatus* (Koken), but it is probable that this specimen is synonymous with the Australian species.

Order Apodes

Family Congridae

Genus **Uroconger** Kaup, 1856

1856 Kaup, *Cat. Apod. Fish. Br. Mus.,* 110.

Uroconger rectus (Frost)

(Pl. XIII, figs. 3, 12)

1928 *Congeris rectus* Frost G.A., *Trans. N.Z. Inst.*, 59; 93.

Types: Hypotypes P 16944-5.

Dimensions: Fig. 12—Length 3·90 mm., width 2·05 mm. Fig. 3—Length 2·95 mm., width 1·86 mm.

Description: Right, biconvex, sagitta otoliths, pointed posteriorly and anteriorly. Dorsal rim flattened, posterior and anterior rims oblique, ventral rim rounded. Outer and inner faces smooth. Sulcus opening on anterior rim and extending diagonally half way across the face of the otolith. Very short, triangular ostium and short, narrow cauda. No colliculi.

These otoliths are identified with the form described by Frost (loc. cit.) from the Lower Miocene or Oligocene of Otiake and Clifden, New Zealand. The character of the sulcus and general outline are comparable with otoliths from the living species *Uroconger lepturus* Richardson, and the fossil form is referred to this genus.

Occurrence and localities: 2 specimens P 16944-5, Balcombian (Miocene) Beds H-K, Balcombe Bay, Victoria, D. Curry collection. One specimen P 16950, Kalimnan (Lower Pliocene), McDonald's Bank, Muddy Creek, Victoria, Dennant collection.

Genus **Astroconger** Jordan and Hubbs, 1925

1925 Jordan and Hubbs, *Mem. Carn. Mus., 10*; 192.

Astroconger rostratus n.sp.

(Pl. XIII, fig. 16)

Type: Holotype P 16946.

Dimensions: Length 6·00 mm., width 2·37 mm.

Description: An elongate, narrow, biconvex, left sagitta otolith, beaked posteriorly, pointed anteriorly. Dorsal and ventral rims slightly rounded. Outer and inner faces smooth. Narrow sulcus running nearly parallel to the ventral rim and extending across three quarters of the inner face of the otolith. It is divided into ostium and cauda by a slight widening of the anterior third of the sulcus. A shallow depression above the crista superior. No colliculi.

This otolith generally resembles those of the living form *Astroconger myriaster* Brevoort, but differs in the beaked posterior form of the fossil, from which the specific name is derived.

Occurrence and locality: One specimen, *Glycymeris* Beds (Oligocene), Bird Rock, Torquay, Victoria, D. Curry collection.

Family Muraenesocidae

Genus **Muraenesox** McClelland, 1843

1843 McClelland, *Calcutta Journ. Nat. Hist., 4*; 408.

Muraenesox obrutus n.sp.

(Pl. XIII, fig. 2)

Type: Holotype P 16947.

Dimensions: Length 4·36 mm., width 2·54 mm.

Description: A biconvex, left sagitta otolith, pointed posteriorly. Dorsal rim straight, anterior rim oblique, ventral rim rounded. Smooth outer and inner faces. Slight diagonal sulcus opening on anterior rim and not reaching posterior rim. Very

short, triangular ostium and longer, narrower cauda. No rostrum, antirostrum or excisura.

Although somewhat eroded, the sulcus of this otolith is typical of the genus *Muraenesox*, resembling otoliths of the living *Muraenesox talabon* Cantor, to which genus this specimen is assigned. The specific name means "buried".

Occurrence and locality: One specimen, Balcombian (Miocene), Clifton Bank, Muddy Creek, near Hamilton, Victoria, Dennant collection.

Family Heterenchelyidae

Genus **Heterenchelys** Regan, 1912

1912 Regan, T., *Ann. Mag. Nat. Hist.*, (8), *10*; 377-387.

Heterenchelys regularis n.sp.

(Pl. XIII, fig. 20)

Type: Holotype P 16948.

Dimensions: Length 9·04 mm.; width, 5·88 mm.

Description: A biconvex, left sagitta otolith, roughly rhomboidal in outline. Pointed anteriorly and posteriorly. Dorsal and ventral rim rounded. Outer and inner faces smooth. Sulcus somewhat diagonal, consisting of a wide, short, triangular ostium opening on the anterior rim and a short, straight cauda. Sulcus filled with a colliculum. No rostrum, antirostrum or excisura. A shallow, rectangular depression above the crista superior.

This otolith compares closely with those of the living *Heterenchelys macrurus* Regan, but differs in its more rhomboidal outline.

Occurrence and localities: P 16948 Balcombian (Miocene), Gellibrand Clay, near Princetown, Victoria; P 16949 Balcombian (Miocene), Shelford, Victoria; Dennant collection.

Order Anacanthini

Family Merluccidae

Genus **Merluccius** Rafinesque, 1810

1810 Rafinesque, *Carratt. di Alc. Nuovi Gen., etc.*, 25.

Merluccius fimbriatus n.sp.

(Pl. XIII, fig. 27)

Type: Holotype P 16951.

Dimensions: Length 14·78 mm., width 5·25 mm.

Description: A thin, right sagitta otolith, somewhat abraded. Dorsal rim rather irregularly denticulated; ventral rim rounded and fimbriated; vertical, fimbriated anterior rim. Pointed posteriorly. Outer face ornamented with parallel ribbing from the median line to all the rims with a prominent diagonal ridge from the antero-dorsal corner to the centre of the otolith. Smooth, inner face with an enclosed sulcus divided nearly equally into ostium and cauda by a marked lower notch. Ostium and cauda partially filled with colliculi.

This is a typical merlucciid otolith comparing well with those of the living *Merluccius vulgaris* Fleming, but differing in its outline.

Occurrence and locality: One specimen, Balcombian (Miocene), Balcombe Bay, Victoria, R. W. T. Wilkins collection.

Family Gadidae

Genus **Gadus** Linnaeus, 1758

1758 Linnaeus (Artedi), *Syst. Nat.*, ed. X; 251.

Gadus refertus n.sp.

(Pl. XIII, figs. 7, 15)

Types: Holotype P 16952; paratype P 16953.

Dimensions: Fig. 7—Length 4·26 mm., width 2·32 mm. Fig 15—Length 5·71 mm., width 4·25 mm.

Description: A left, biconvex, sagitta otolith prominently pointed posteriorly. Dorsal rim rounded, with a projecting knob at its junction with the oblique anterior rim. Ventral rim rounded. Outer face showing several large, indistinct tuberculations. Smooth inner face. Enclosed sulcus which is divided near its centre into ostium and cauda by a lower notch and diagonal line. Ostium and cauda spherical and filled with colliculi to the level of the surrounding face of the otolith.

Fig. 15 is an eroded left specimen in which the sulcus closely resembles the type found in ophidioid otoliths.

The general outline of this otolith, together with the characteristic sulcus, place it in the genus *Gadus*, comparing well with otoliths of the living *Gadus luscus* Linnaeus. The specific name refers to the filled-in sulcus.

Occurrence and localities: One specimen P 16952 Janjukian (Oligocene), Spring Creek, Victoria, Dennant collection. One specimen P 16953 *Glycymeris* Beds (Oligocene), Bird Rock, Torquay, Victoria, D. Curry collection.

Family Bregmacerotidae

Genus **Bregmaceros** (Cantor) Thompson, 1840

1840 (Cantor) Thompson, in *Charlesworth's Mag. Nat. Hist.*, 184.

Bregmaceros minutus n.sp.

(Pl. XIII, fig. 22)

Type: Holotype P 16954.

Dimensions: Length 0·98 mm., width 1·09 mm.

Description: A minute, left sagitta otolith. High dorsal rim, rounded posterior and anterior rims, the latter with a rounded upper notch; straight ventral rim. Smooth, convex outer face. Smooth, flat inner face. Sulcus enclosed, consisting of a median, slightly curved, narrow groove with a slight central constriction. A slight, triangular depression above the crista superior. No colliculi.

This otolith shows a marked resemblance to those of the living form *Bregmaceros atripinnis* Day, but differs in the notch on the antero-dorsal rim.

Occurrence and locality: 6 specimens, Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, P 16954 and P 17307-11, D. Curry collection.

Famliy Coryphaenoididae

Genus **Coelorhynchus** Giorna, 1803

1803 Giorna, *Mem. Ac. Sci. Turin*, 16; 178. Pl. I, figs. 3, 4.

Coelorhynchus elevatus Stinton

(Pl. XIII, figs. 9, 13, 17)

1924 *Otolithus (Macrurus) toulai* Frost G. A., *Trans. N.Z. Inst.*, 55; 608.
non Schubert R. J., *Jb. geol. Reichsanst.*, 55; 620, 1905.
1956 *Coelorhynchus elevatus* Stinton F. C., *Trans. Roy. Soc. N.Z.*, 84, pt. 3. Pl. XXXII, fig. 13.

Types: Hypotypes P 16955-57.

Dimensions: Fig. 9—Length 6·04 mm., width 4·13 mm. Fig. 13—Length 4·60 mm., width 3·35 mm. Fig. 17—Length 6·36 mm., width 4·00 mm.

Description: Biconvex, left sagitta otoliths, pointed posteriorly and anteriorly. High, denticulated dorsal rim, nearly vertical; denticulated posterior rim; finely denticulated, rounded ventral rim. Outer face strongly ribbed on all the rims. Smooth inner face with a narrow, median, shallow sulcus which almost touches the posterior and anterior ends of the otolith. Ostium sphaeroidal and shorter than the long, wider cauda which is separated by a constriction of the superior and inferior cristae. No colliculi.

This form, described by Frost (1924, loc. cit.) as *Macrurus toulai* Schubert, is obviously referable to the genus *Coelorhynchus* when compared with otoliths from the living *Coelorhynchus fasciatus* Gnthr. Examination of the indistinct figures of Schubert's species *Macrurus toulai* shows a relatively shorter otolith with a wider sulcus in keeping with a typical otolith of the genus *Macrurus* sensu stricto.

Occurrence and localities: P 16955 Balcombian (Miocene), Balcombe Bay, Victoria, R. W. T. Wilkins collection; P 16956 Balcombian (Miocene), Shelford, Victoria, Dennant collection; P 16957 Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Order Berycomorphi

Family Monocentridae

Genus **Monocentris** Bloch and Schneider, 1801

1801 Bloch and Schneider, *Syst. Ichth.*, 100.

Monocentris sphaeroides n.sp.

(Pl. XIII, fig. 25)

Type: Holotype P 16958.

Dimensions: Length 7·46 mm., width 7·77 mm.

Description: A deep, oval, left sagitta otolith. All rims regularly rounded with a faint scalloping on the dorsal rim. Outer face convex, ornamented on the antero-dorsal rim with short, parallel ribs. Flat inner face. Sulcus opening narrowly on the anterior rim, crossing the middle of the otolith and not reaching the posterior rim. Wide, shallow, down-turned ostium; up-turned, oval, shallow cauda. Ostium and cauda sharply delineated by a prominent notch on the crista inferior. The concave crista superior has a wide, shallow depression above it. No rostrum, antirostrum, excisura or colliculi.

This otolith compares closely with those of the living species *Monocentris japonicus* Houttuyn, but differs in its more oval outline. *Monocentris lemoinei* Priem, described by Frost (1924, loc. cit.) from Balcombe Bay, Victoria, is a relatively more rounded otolith.

Occurrence and locality: One specimen, Pliocene, Aldinga, South Australia, Dennant collection

Genus **Cleidopus** de Vis, 1883

1882 de Vis, *Proc. Linn. Soc. N.S.W.*, 7; 367.

Cleidopus cavernosus n.sp.

(Pl. XIII, fig. 26)

Type: Holotype P 16959.

Dimensions: Length 5·23 mm., width 6·00 mm.

Description: A right, sagitta otolith. Dorsal rim straight and slightly sloping upwards posteriorly. Produced slightly at junction of dorsal and posterior rims. Anterior and posterior rims nearly vertical and slightly rounded. Ventral rim nearly horizontal. Convex outer face ornamented on the upper half with 3 wide, indistinct, radial tuberculations. Inner face nearly flat. A wide, excavated, median sulcus opening narrowly on the anterior rim and nearly reaching the posterior rim. Ostium wide, shallow, circular; cauda short, wide, spherical, sharply delineated by prominent notches on the upper and lower rims of the sulcus. No rostrum, antirostrum, excisura or colliculi. A very narrow, shallowly depressed area above the sulcus and a wide area below it.

The outline and sulcus of this otolith compare closely with those of the living *Cleidopus gloria-maris* de Vis, but it differs in the more rounded, straighter and wider cauda. The otolith of the living form is markedly more produced in the postero-dorsal area and possibly the fossil form is similarly more produced but it has suffered somewhat from attrition. The Recent otoliths were obtained from two extant examples from Surfers' Paradise, Queensland, kindly supplied to the author by Mrs. P. Doran. The specific name refers to the hollowed-out appearance of the sulcus.

Occurrence and locality: One specimen, *Limopsis* Beds (Oligocene), Torquay, Victoria, D. Curry collection.

Family Trachichthyidae

Genus **Trachichthodes** Gilchrist, 1903

1903 Gilchrist, *Mar. Invest. S. Afr., 2*; 203.

Trachichthodes salebrosus n.sp.

(Pl. XIII, figs. 19, 24, 28)

Types: Holotype P 16960, paratypes P 16961-2.

Dimensions: Fig. 19—Length, 2·53 mm., width 2·08 mm. Fig. 24—Length 7·46 mm., width 6·97 mm. Fig. 28—Length 6·33 mm., width 5·36 mm.

Description: A hexagonal, right sagitta otolith. Dorsal and ventral rims straight. Obtuse-angled anterior and posterior rims. Outer face ridged centrally and with short, radial ribs all round the rims, probably producing scalloping in unabraded specimens. The central ridge slopes towards the dorsal and ventral rims. Prominent ribbing on the edge of the outer face is shown in paratype P 16961. Smooth, slightly convex inner face. Central sulcus opening narrowly on the anterior rim and almost reaching the posterior rim. Ostium diagonal, oval, wide shallow; cauda straight, narrow, rather up-turned and differentiated from ostium by a prominent notch on the crista inferior. No rostrum, antirostrum, excisura or colliculi. A shallow depression above the crista superior.

Paratype P 16962 represents a juvenile specimen showing marked scalloping of the rims. It is less hexagonal in outline and is more rounded generally.

This otolith compares closely with those of the living Australian form *Trachichthodes affinis* Guenther, differing only in the ribbing of rims and in being relatively somewhat higher. The specific name refers to the rugged appearance of the outer face.

Occurrence and localities: P 16960 Balcombian (Miocene), Balcombe Bay, Victoria, R. W. T. Wilkins collection; P 16961 Balcombian (Miocene), Shelford, Victoria; P 17312 Janjukian (Oligocene) or (Miocene), Maude, Victoria; P 17313 Balcombian (Miocene), Curlewis, Victoria; P 17314 Balcombian (Miocene), Clifton

Bank, Muddy Creek, near Hamilton, Victoria, Dennant collection; P 16962 Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Order Percomorphi

Sub-order Percoidea

Genus **"Percidarum"**

"Percidarum" clivosum n.sp.

(Pl. XIII, fig. 18)

Type: Holotype P 16963.

Dimensions: Length 2·73 mm., width 1·71 mm.

Description: A thin, right sagitta otolith, pointed anteriorly. Dorsal rim rising posteriorly and denticulated; denticulated, rounded posterior and ventral rims. Concave outer face with small tuberculations all round the edges. Inner face smooth centrally but scalloped towards the rims. A straight, horizontal sulcus opening on the anterior rim and not reaching the posterior rim. A short, shallow ostium and a long, narrower cauda, delineated by a lower and rounded upper angles. Rostrum, slight antirostrum and excisura present. No colliculi. A shallow depression above the crista superior, accentuating it.

Comparison of this otolith with those of the living types at present represented in the author's collection does not show sufficient affinities for its accurate generic determination. In character it is typically percoid and the form of the sulcus compares somewhat with that of otoliths from the living *Grammistes sexlineatus* Thunberg, but it is distinct in general outline. The specific name refers to the hillocky appearance of the ornamentation on the outer face.

Occurrence and locality: One otolith, Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Family Lactariidae

Genus **Lactarius** Cuvier et Valenciennes, 1833

1833 Cuvier et Valenciennes, *Hist. Nat. Poiss.*, *9*; 237.

Lactarius tumulatus n.sp.

(Pl. XIII, fig. 5)

Type: Holotype P 16964.

Dimensions: Length 3·48 mm., width 2·51 mm.

Description: A biconvex, left sagitta otolith. Horizontal dorsal rim, slightly scalloped; vertical posterior rim and rounded anterior rim, both denticulated; oblique anterior rim. Outer face feebly ornamented with irregular tuberculations. Inner face smooth and almost flat. A median sulcus opening on the anterior rim and not quite reaching the posterior rim. Ostium somewhat slanting downwards, oval and relatively wide; cauda straight, narrow, fairly long and slightly downcurved at its extremity. A slight rostrum but no antirostrum or excisura. No colliculi. A slight depression above the crista superior.

This otolith is very similar to those of the living *Lactarius lactarius* Bloch and Schneider, both in its general shape and the character of the sulcus, but differs in the denticulated rims and more flattened dorsal rim. The specific name means "buried".

Occurrence and locality: Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Family Sillaginidae

Genus **Sillago** Cuvier, 1817

1817 Cuvier, *Reg. Anim., 2*; 258.

Sillago pliocaenica Stinton

(Pl. XIII, fig. 4)

1952 Stinton, F. C., *Trans. Roy. Soc. S. Austr., 76*; 66.

Type: Hypotype P 16965.

Dimensions: Length 5·77 mm., width 4·68 mm.

Description: A left, sagitta otolith. Dorsal rim produced to a small, central point and very feebly denticulated. Rounded posterior, ventral and anterior rims. Concave outer face, thickened centrally; feeble radial ridges on the rims, otherwise smooth. Smooth, sharply convex inner face. Sulcus just touching anterior rim, running closely parallel with the dorsal rim, almost to the posterior rim. A short, oval ostium and a fairly wide, undulating cauda separated by a very thin line which curves slightly in its centre. Sulcus entirely filled with colliculi. No rostrum, antirostrum or excisura.

This otolith is the commonest form represented in the Tertiary formations of Victoria and also in the Pliocene of South Australia.

Occurrence and localities: P 16965-79, 15 specimens, Cheltenhamian (Upper Miocene), Cheltenham (= Beaumaris), Victoria; P 16980 Balcombian (Miocene), Shelford, Victoria; P 16981-86, 6 specimens, Janjukian (Oligocene), Spring Creek, Victoria; P 16987-9, 3 specimens, Balcombian (Miocene), Clifton Bank, Muddy Creek, near Hamilton, Victoria; P 16990-1, 2 specimens, Kalimnan (Lower Pliocene), MacDonald's Bank, Muddy Creek, near Hamilton, Victoria; P 16992-17000 and 17154-8, 14 specimens, Janjukian (Oligocene) or (Miocene), Maude, Victoria; P 17159-60, 2 specimens, Miocene, Mitchell River, Victoria; Dennant collection.

Sub-order Ophidioidea

Family Carapidae

Genus **Jordanicus** Gilbert, 1905

1905 Gilbert, *Bull. U.S. Fish. Comm., 23* (1903); pt. 2, 656.

Jordanicus exiguus Stinton

1956 *Jordanicus exiguus* Stinton F. C., *Trans. Roy. Soc. N.Z., 84*; pt. 3. Pl. XXXII, fig. 9.

Types: Hypotypes P 17161-2.

Dimensions: Fig. 6—Length 3·56 mm., width 2·18 mm. Fig. 11—Length 4·57 mm., width 2·04 mm.

Description: Triangular, biconvex, left sagitta otoliths, pointed anteriorly and posteriorly. Domed, dorsal rim, feebly scalloped; slightly rounded ventral rim. Outer face ornamented with radial tuberculations on the dorsal rim, otherwise smooth. Smooth inner face. Sulcus completely enclosed, triangular, undivided and completely filled with a colliculum.

This otolith compares well with otoliths from the living *Jordanicus gracilis* Bleeker, but is relatively longer and less biconvex than the living form.

Occurrence and locality: P 17161, Balcombian (Miocene), Curlewis, Victoria; P 17162, (Miocene), Mitchell River, Victoria; Dennant collection.

Family Ophidiidae

Genus **Ophidion** Linnaeus, 1758

1758 Linnaeus, *Syst. Nat.*, ed. X, 242; 259.

The name *Ophidium* is found in Linnaeus's *Systema Naturae* (12 ed.) and is generally used but *Ophidion* is the genus officially listed in the Rules of Zoological Nomenclature (op. 92).

Ophidion granosum n.sp.

(Pl. XIII, fig. 14)

Type: Holotype P 17411.

Dimensions: Length 2·45 mm., width 1·40 mm.

Description: A biconvex, left sagitta otolith, pointed posteriorly. Dorsal rim straight, anterior and ventral rims rounded, posterior rim very short and oblique. Outer face ornamented with indistinct tuberculations which are more distinct on the antero-ventral rims. Inner face smooth and almost flat. Sulcus entirely enclosed. Ostium long and oval, cauda very small, circular and differentiated from the ostium by a prominent notch on the lower rim. Sulcus completely filled with colliculi.

This otolith is typical of the genus *Ophidion* in its outline and the character of the sulcus. The specific name refers to the resemblance of this otolith to a small seed or pip.

Occurrence and locality: Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Order Scleroparei

Family Platycephalidae

Genus **Platycephalus** Bloch, 1795

1795 Bloch, *Ichthyol., 12*; 90.

Platycephalus petilus n.sp.

(Pl. XIII, fig. 1)

Type: Holotype P 17412.

Dimensions: Length 6·37 mm., width 2·46 mm.

Description: A rather waterworn, thin, narrow, elongate right sagitta otolith, pointed anteriorly and posteriorly. Dorsal rim rounded and feebly scalloped, ventral rim rounded and scalloped, at its posterior end. Outer face concave with radial ribbing to the dorsal rim, the ribbing being finer at the posterior end. Inner face convex with faint ribbing on the dorsal half. A narrow, somewhat deep sulcus opening narrowly on the anterior rim and extending two-thirds of the way across the otolith. Ostium slightly wider than cauda and equal in length to it. Cauda slightly down-curved at its pointed extremity. A slight rostrum but no antirostrum or excisura. No colliculi.

This otolith compares closely with those of the living *Platycephalus insidiator* Forskål, but it is relatively wider than the living form. The specific name refers to the thin, narrow form of the otolith.

Occurrence and locality: Miocene, Mitchell River, Victoria, Dennant collection.

Order Heterosomata

Family Pleuronectidae

Genus **Pleuronectes** (Artedi) Linnaeus, 1758

1758 (Artedi) Linnaeus, *Syst. Nat.*, ed. *X*, 268.

Pleuronectes vulsus n.sp.

(Pl. XIII, fig. 10)

Type: Holotype P 17413.

Dimensions: Length 3·04 mm. (incomplete), width 1·83 mm.

Description: An incomplete, oval, biconvex right sagitta otolith, the anterior end missing. Pointed posteriorly. Dorsal and ventral rims rounded. Outer and inner faces smooth. Sulcus excavated and possibly enclosed but anterior characters lost. Ostium apparently a shallow, oval depression; cauda a much smaller, circular depression, somewhat upturned.

The character of the sulcus suggests a close affinity to the *Pleuronectidae* in which genus this otolith is tentatively placed. The specific name refers to the smoothness of the otolith.

Occurrence and locality: Balcombian (Miocene), Beds H-K, Balcombe Bay, Victoria, D. Curry collection.

Conclusions

The otolith assemblage suggests a rather deep-water facies, possibly deposited on the edge of the continental shelf, as evidenced by the presence of the genera *Pterothrissus, Bregmaceros, Ophidion* and the pelagic *Megalops*. However, the occurrence of *Platycephalus* and *Lactarius* suggests more littoral conditions and, as this peculiar admixture of genera occurs throughout the Eocene of Europe, as in the Tertiary of Australia, it is possible that the deep-sea forms of the present day were able to exist in more littoral circumstances during Eocene times. This might be explained by the temperature of the water being more equable during the life of the fossil forms. those more susceptible to temperature variation having migrated to deeper water when conditions became unfavourable in the littoral zone.

While the otoliths of *Platycephalus, Sillago* and *Lactarius* approach most closely to those of the living East Indian species, suggesting a climate comparable with those parts, the occurrence of *Merluccius* indicates a more temperate influence. It seems probable that the climate existing during Tertiary times was subtropical.

Acknowledgements

My thanks are due to Mr. Edmund D. Gill for his kindness in permitting me to see the specimens described above and for advice regarding stratigraphical details. Mr. D. Curry has materially assisted me with the specimens collected by him in Victoria.

Also, without the otoliths of living forms, so kindly supplied by the following, it would have been impossible to identify the fossil forms—Dr. R. Paulian, Deputy Director, Institut Scientifique de Madagascar; M. J. Cadenat, Director, Laboratoire de Biologie Marine de l'I.F.A.N., Senegal; Dr. J. Westenberg, Zoological Station, den Helder, Netherlands; Dr. J. D. F. Hardenberg, Marine Laboratory, Penjelidikan Laut, Djakarta, Indonesia; Mr. Takashi Ino, Tokai Regional Fisheries Research Laboratory, Tokyo, Japan; Mr. N. B. Marshall, Department of Fishes, British Museum (Natural History), London; Dr. K. H. Barnard, Cape Town, South Africa; Dr. C. von Bonde, Cape Town, South Africa; G. W. Rayner, Esq., Marine Biological Laboratory, Cronulla, New South Wales, Australia; and Mr. H. M. Hale, South Australian Museum, Adelaide, Australia.

I am most grateful for the help given by Mr. D. Storey, Christchurch, Hants, who kindly photographed all the specimens.

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Explanation of Plate

PLATE XIII

Fig. 1.—*Platycephalus petilus* n.sp. Inner face. Miocene, Mitchell River, Victoria. P 13708. Dennant collection. × 6.

Fig. 2.—*Muraenesox obrutus* n.sp. Inner face. Balcombian, Clifton Bank, Muddy Creek, Victoria. P 16947. Dennant collection. × 6.

Fig. 3.—*Uroconger rectus* (Frost). Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16945. D. Curry collection. × 6.

Fig. 4.—*Sillago pliocaenica* Stinton. Inner face. Cheltenhamian, Cheltenham (= Beaumaris), Victoria. P 16965. Dennant collection. × 6.

Fig. 5.—*Lactarius tumulatus* n.sp. Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16964. D. Curry collection. × 6.

Fig. 6.—*Jordanicus exiguus* Stinton. Outer face. Miocene, Mitchell River, Victoria. P 17162. Dennant collection. × 6.

Fig. 7.—*Gadus refertus* n.sp. Inner face. Janjukian, Spring Creek, Victoria. P 16952. Dennant collection. × 6.

Fig. 8.—*Megalops lissa* n.sp. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16938. Inner face. D. Curry collection. × 12.

Fig. 9.—*Coelorhynchus elevatus* Stinton. Inner face. Balcombian, Balcombe Bay, Victoria. P 16955. R. W. T. Wilkins collection. × 6.

Fig. 10.—*Pleuronectes vulsus* n.sp. Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 13709. D. Curry collection. × 6.

Fig. 11.—*Jordanicus exiguus* Stinton. Inner face. Balcombian, Curlewis, Victoria. P 17161. Dennant collection. × 6.

Fig. 12.—*Uroconger rectus* (Frost). Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16944. D. Curry collection. × 6.

Fig. 13.—*Coelorhynchus elevatus* Stinton. Inner face. Balcombian. Beds H-K, Balcombe Bay, Victoria. P 16957. D. Curry collection. × 6.

Fig. 14.—*Ophidion granosum* n.sp. Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 13707. D. Curry collection. × 6.

Fig. 15.—*Gadus refertus* n.sp. Inner face. *Glycymeris* Beds, Bird Rock, Torquay, Victoria. P 16953. D. Curry collection. × 6.

Fig. 16.—*Astroconger rostratus* n.sp. Inner face. *Glycymeris* Beds, Bird Rock, Torquay, Victoria. P 16946. D. Curry collection. × 6.

Fig. 17.—*Coelorhynchus elevatus* Stinton. Outer face. Balcombian, Shelford, Victoria. P 16956. Dennant collection. × 6.

Fig. 18.—*Percidarum clivosum* n.sp. Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16963. D. Curry collection. × 12.

Fig. 19.—*Trachichthodes salebrosus* n.sp. Inner face. Juvenile. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16962. D. Curry collection. × 6.

Fig. 20.—*Heterenchelys regularis* n.sp. Inner face. Balcombian, Gellibrand Clay, Victoria. P 16948. Dennant collection. × 6.

Fig. 21.—*Pterothrissus pervetustus* n.sp. Inner face. Janjukian, Spring Creek, Victoria. P 16941. Dennant collection. × 6.

Fig. 22.—*Bregmaceros minutus* n.sp. Inner face. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16954. D. Curry collection. × 12.

Fig. 23.—*Megalops lissa* n.sp. Inner face, juvenile. Balcombian, Beds H-K, Balcombe Bay, Victoria. P 16949. D. Curry collection. × 12.

Fig. 24.—*Trachichthodes salebrosus* n.sp. Outer face. Balcombian, Shelford, Victoria. P 16961. Dennant collection. × 6.

Fig. 25.—*Monocentris sphaeroides* n.sp. Inner face. Aldinga, South Australia. P 16958. Dennant collection. × 6.

Fig. 26.—*Cleidopus cavernosus* n.sp. Inner face. *Limopsis* Beds, Torquay, Victoria. P 16959. D. Curry collection. × 6.

Fig. 27.—*Merluccius fimbriatus* n.sp. Inner face. Balcombian, Balcombe Bay, Victoria. P 16951. R. W. T. Wilkins collection. × 6.

Fig. 28.—*Trachichthodes salebrosus* n.sp. Inner face. Balcombian, Balcombe Bay, Victoria. P 16960. R. W. T. Wilkins collection. × 6.